

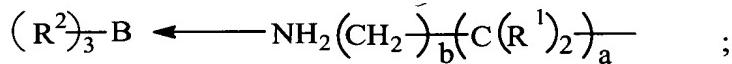
WHAT IS CLAIMED IS:

1. A method for repairing fuel tanks which comprises providing a fuel tank having a surface with detected leaks, filling the detected leaks by applying an adhesive over the detected leaks and allowing the adhesive to cure to seal the detected leaks.

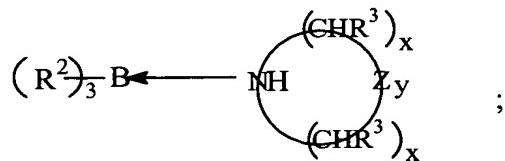
2. The method of Claim 1 wherein the adhesive comprises an amine/organoborane complex.

3. The method of Claim 2 wherein the organoborane is a trialkyl borane or alkyl cycloalkyl borane and the amine is selected from the group consisting of (1) amines having an amidine structural component; (2) aliphatic heterocycles having at least one nitrogen in the heterocyclic ring wherein the heterocyclic compound may also contain one or more nitrogen atoms, oxygen atoms, sulfur atoms, or double bonds in the heterocycle; (3) primary amines which in addition have one or more hydrogen bond accepting groups wherein there are at least two carbon atoms, preferably at least three carbon atoms, between the primary amine and the hydrogen bond accepting group, such that due to inter- or intramolecular interactions within the complex the strength of the B-N bond is increased; and (4) conjugated imines.

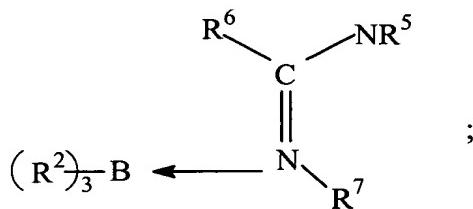
4. The method of Claim 3 wherein the complex of the organoborane and the primary amine corresponds to the formula



the organoborane heterocyclic amine complex corresponds to the formula



the organoborane amidine complex corresponds to the formula



and the organoborane conjugated imine complex corresponds to the formula



wherein B is boron; R¹ is separately in each occurrence hydrogen, a C₁₋₁₀ alkyl or C₃₋₁₀ cycloalkyl; R² is separately in each occurrence a C₁₋₁₀ alkyl, C₃₋₁₀ cycloalkyl or two or more of R² may combine to form a cycloaliphatic ring structure; R³ is separately in each occurrence hydrogen, a C₁₋₁₀ alkyl or C₃₋₁₀ cycloalkyl; R⁴ is separately in each occurrence hydrogen, C₁₋₁₀ alkyl, C₃₋₁₀ cycloalkyl, C₆₋₁₀ aryl or alkaryl; R⁵, R⁶, and R⁷ are separately in each occurrence hydrogen, C₁₋₁₀ alkyl, C₃₋₁₀ cycloalkyl, or two or more of R⁵, R⁶ and R⁷ in any combination can combine to form a ring structure which can be a single ring or a multiple ring structure and the ring structure can include one or more of nitrogen, oxygen or unsaturation in the ring structure; R⁹ is independently in each occurrence hydrogen, C₁₋₁₀ alkyl or C₃₋₁₀ cycloalkyl, Y, -(C(R⁹)₂-(CR⁹=CR⁹)_c-Y or two or more of R⁹ can combine to form a ring structure, or one or more of R⁹ can form a ring structure with Y provided the ring structure is conjugated with respect to the double bond of the imine nitrogen; X is a hydrogen-bond accepting group with the proviso that where the hydrogen bond accepting group is an amine it must be secondary or tertiary; Y is independently in each occurrence hydrogen, N(R⁴)₂, OR⁴, C(O)OR⁴, a halogen or an alkylene group which forms a cyclic ring with R⁷ or R⁹; Z is separately in each occurrence oxygen or -NR⁴; a is separately in each occurrence an integer of from 1 to 10; b is separately in each occurrence 0 or 1, with the proviso that the sum of a and b should be from 2 to 10; c is separately in each occurrence an integer of from 1 to 10; x is separately in each occurrence an integer of 1 to 10, with the proviso that the total of all occurrences of x is from 2 to 10; and y is separately in each occurrence 0 or 1.

5. The method of Claim 2 wherein the organo borane/amine complex comprises an aliphatic heterocyclic amine which is a five or six membered heterocyclic compound.

6. The method of Claim 2 wherein the organo borane compound of the complex has three ligands selected from C₁₋₁₀ alkyl groups or phenyl groups, and the amine compound is selected from 1,6 diaminohexane, diethylamine, dibutylamine, diethylenetriamine, dipropylenediamine, 1,3 propylene diamine, and 1,2 propylene diamine.

7. The method of Claim 2 wherein the organoborane compound of the complex has three ligands attached to the borane atom and which are selected from C₁₋₁₀ alkyl groups and phenyl and the amine compound is an alkanol amine or a diamine wherein the first amine group is a primary or secondary amine and the second amine is a primary amine.

8. The method of Claim 2 wherein the amine compound of the complex is a polyoxyalkylene polyamine or a polyamine which is the reaction product of a diprimary amine and a compound having at least two groups which react with a primary amine.

9. The method of Claim 1 wherein the fuel tank is made of stainless steel, pre-coated or post-coated low-carbon steel, aluminum, bronze, electroplated zinc, nickel or galvanneal.

10. The method of Claim 1 wherein the fuel tank is made of metal or a multilayer structure having one or more layers of a polymer having fuel barrier property and one or more layers of a low energy surface material.

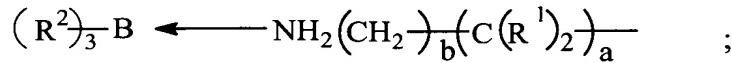
11. The method of Claim 10 wherein the low energy surface material is high density polyethylene and the fuel barrier polymer is selected from the group consisting of polyamides, fluoroelastomers, polyacetal homopolymers and copolymers, sulfonated and fluorinated HDPE, ethylene vinyl alcohol polymers and copolymers, hydroxy-functionalized polyethers and polyesters, and branched polyesters.

12. The method of Claim 1 wherein the adhesive comprises an adhesive having fuel barrier property and which bonds to low energy surface materials.

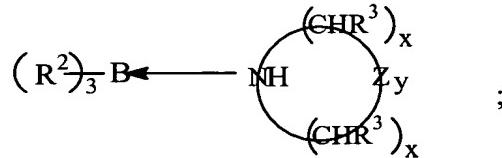
13. The method of Claim 12 wherein the adhesive comprises an amine/organoborane complex.

14. The method of Claim 13 wherein the organoborane is a trialkyl borane or alkyl cycloalkyl borane and the amine is selected from the group consisting of (1) amines having an amidine structural component; (2) aliphatic heterocycles having at least one nitrogen in the heterocyclic ring wherein the heterocyclic compound may also contain one or more nitrogen atoms, oxygen atoms, sulfur atoms, or double bonds in the heterocycle; (3) primary amines which in addition have one or more hydrogen bond accepting groups wherein there are at least two carbon atoms, preferably at least three carbon atoms, between the primary amine and the hydrogen bond accepting group, such that due to inter- or intramolecular interactions within the complex the strength of the B-N bond is increased; and (4) conjugated imines.

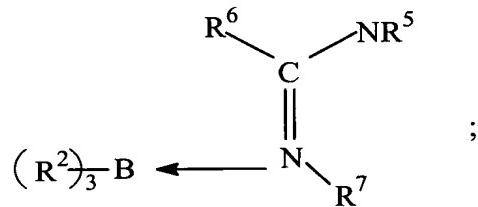
15. The method of Claim 14 wherein the complex of the organoborane and the primary amine corresponds to the formula



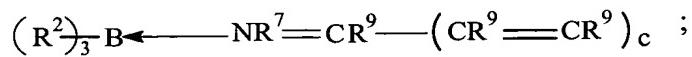
the organoborane heterocyclic amine complex corresponds to the formula



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and the organoborane conjugated imine complex corresponds to the formula



wherein B is boron; R¹ is separately in each occurrence hydrogen, a C₁₋₁₀ alkyl or C₃₋₁₀ cycloalkyl; R² is separately in each occurrence a C₁₋₁₀ alkyl, C₃₋₁₀ cycloalkyl or two or more of R² may combine to form a cycloaliphatic ring structure; R³ is separately in each occurrence hydrogen, a C₁₋₁₀ alkyl or C₃₋₁₀ cycloalkyl; R⁴ is separately in each occurrence hydrogen, C₁₋₁₀ alkyl, C₃₋₁₀ cycloalkyl, C₆₋₁₀ aryl or alkaryl; R⁵, R⁶, and R⁷ are separately in each occurrence hydrogen, C₁₋₁₀ alkyl, C₃₋₁₀ cycloalkyl, or two or more of R⁵, R⁶ and R⁷ in any combination can combine to form a ring structure which can be a single ring or a multiple ring structure and the ring structure can include one or more of nitrogen, oxygen or unsaturation in the ring structure; R⁹ is independently in each occurrence hydrogen, C₁₋₁₀ alkyl or C₃₋₁₀ cycloalkyl, Y, -(C(R⁹)₂-(CR⁹=CR⁹)_c-Y or two or more of R⁹ can combine to form a ring structure, or one or more of R⁹ can form a ring structure with Y provided the ring structure is conjugated with respect to the double bond of the imine nitrogen; X is a hydrogen-bond accepting group with the proviso that where the hydrogen bond accepting group is an amine it must be secondary or tertiary; Y is independently in each occurrence hydrogen, N(R⁴)₂, OR⁴, C(O)OR⁴, a halogen or an alkylene group which forms a cyclic ring with R⁷ or R⁹; Z is separately in each occurrence oxygen or -NR⁴; a is separately in each occurrence an integer of from 1 to 10; b is separately in each occurrence 0 or 1, with the proviso that the sum of a and b should be from 2 to 10; c is separately in each occurrence an integer of from 1 to 10; x is separately in each occurrence an integer of 1 to 10, with the proviso that the total of all occurrences of x is from 2 to 10; and y is separately in each occurrence 0 or 1.

16. The method of Claim 14 wherein the organo borane/amine complex comprises an aliphatic heterocyclic amine which is a five or six membered heterocyclic compound.

17. The method of Claim 13 wherein the organo borane compound of the complex has three ligands selected from C₁₋₁₀ alkyl groups or phenyl groups, and the amine compound is selected from 1,6 diaminohexane, diethylamine, dibutylamine, diethylenetriamine, dipropylenediamine, 1,3 propylene diamine, and 1,2 propylene diamine.

18. The method of Claim 13 wherein the organoborane compound of the complex has three ligands attached to the borane atom and which are selected from C₁₋₁₀ alkyl groups and phenyl and the amine compound is an alkanol amine or a diamine wherein the first amine group is a primary or secondary amine and the second amine is a primary amine.

19. The method of Claim 13 wherein the amine compound of the complex is a polyoxyalkylene polyamine or a polyamine which is the reaction product of a diprimary amine and a compound having at least two groups which react with a primary amine.

20. The method of Claim 1 wherein the fuel tank is made of metal or a monolayer or multilayer plastic.

21. The method of Claim 1 wherein the adhesive comprises a polyurethane-, epoxy-, polyimide-, phenolic/resorcinolic-, or acrylate-based adhesive.

22. The method of Claim 1 wherein the fuel tank surface is cleaned and/or pre-treated to provide adequate bonding between the adhesive and the fuel tank.

23. The method of Claim 22 wherein the exterior and/or interior surface of the fuel tank is cleaned with water and or soap, or solvent.

24. The method of Claim 22 wherein the exterior and/or interior surface of the fuel tank is sanded or sandblasted.

25. A method for repairing fuel tanks which comprises providing a fuel tank having a surface with detected leaks, providing a patch or plug having a surface to be attached to the fuel tank surface with detected leaks, coating the tank surface and/or the patch or plug surface with an adhesive, placing the patch or plug over the detected leak(s) such that the adhesive is sandwiched between the patch or plug surface and the tank surface, pressing the patch or plug against the tank and allowing the adhesive to cure to bond together the patch or plug surface and the tank surface.

26. The method of Claim 25 wherein the patch is made of woven or non-woven fabric, a composite material or a monolayer or multilayer plastic laminate.